Phase2
Track Analysis

Purpose:

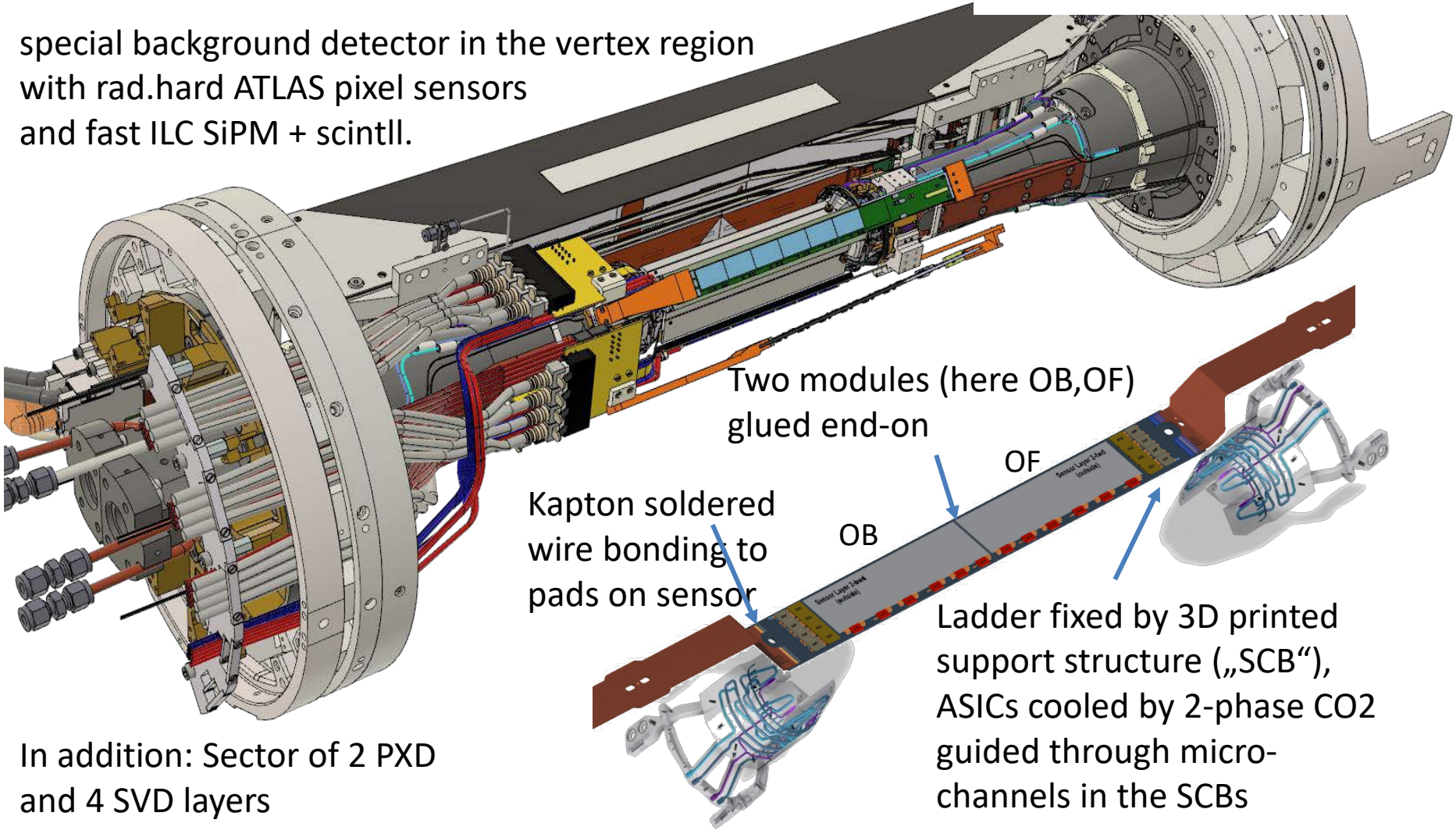
Study Vertex / Particle Distributions from Luminosity runs

Phase 2 „Vertex“ Detector

First nano-beam collisions during Phase 2

special background detector in the vertex region
with rad.hard ATLAS pixel sensors
and fast ILC SiPM + scintll.

Vertex detector mounted
on the beam pipe



In addition: Sector of 2 PXD
and 4 SVD layers

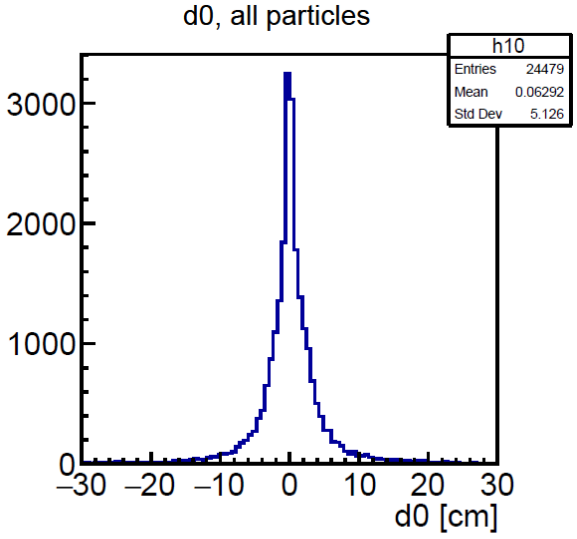
Data Preparation

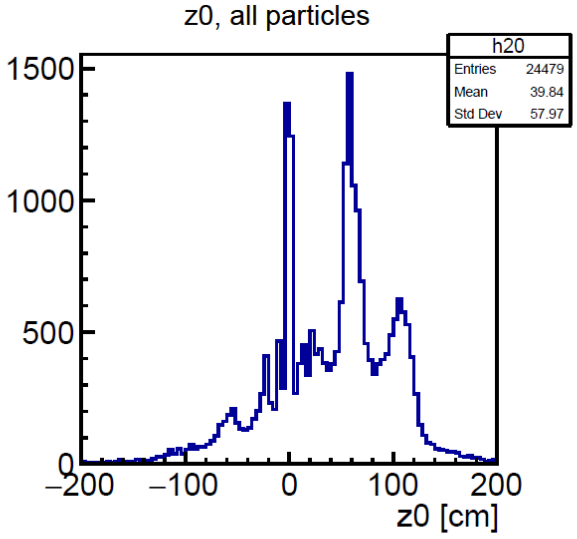
Data reconstruction: BASF2 release-02-00-01 (Prod 5)
Run at KEK, input: DST
prepare a „mini-DST“ with the following variables
list_of_variables = [
'expNum', 'runNum', 'evtNum', 'nTracks', 'E', 'px', 'py', 'pz', 'p', 'cosTheta', 'dr', 'd0', 'phi0', 'omega', 'z0', 'tanlambda', 'pionID', 'muonID', 'electronID', 'protonID'
]

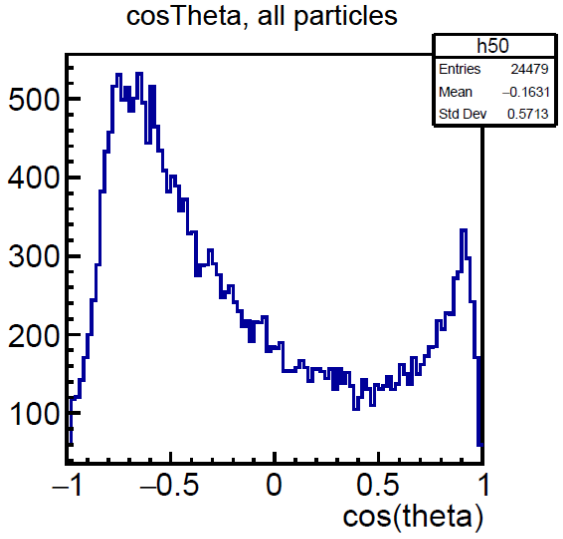
Select runs towards the end of Phase 2
(inproved injection)

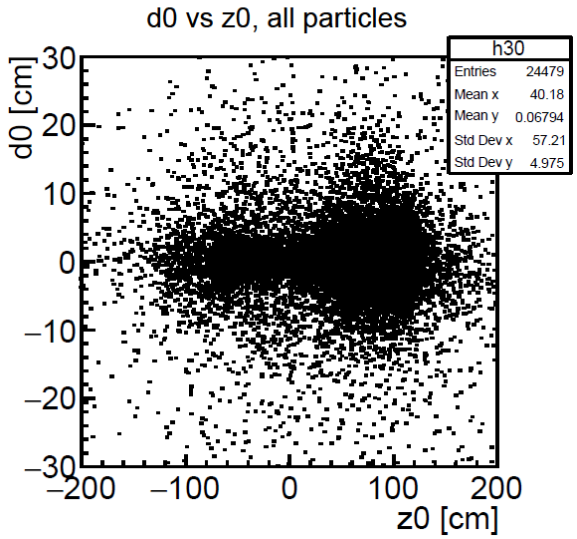
Run	Date	Curr.[mA]	# Bunches	Size y[µm]	CDC [µA]	vac [10^{-8} Torr]
4814	06/29	240/230	789	101/108	24.2	3.0 / 6.7
5187	07/04	217/226	395	68/145	19.6	1.9 / 4.3

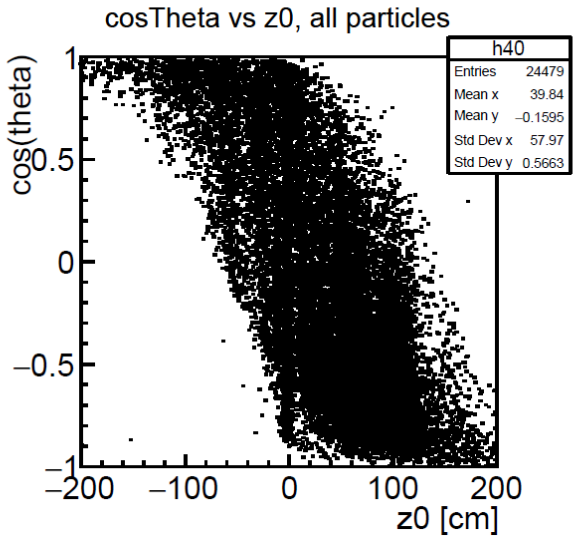
Run 4814

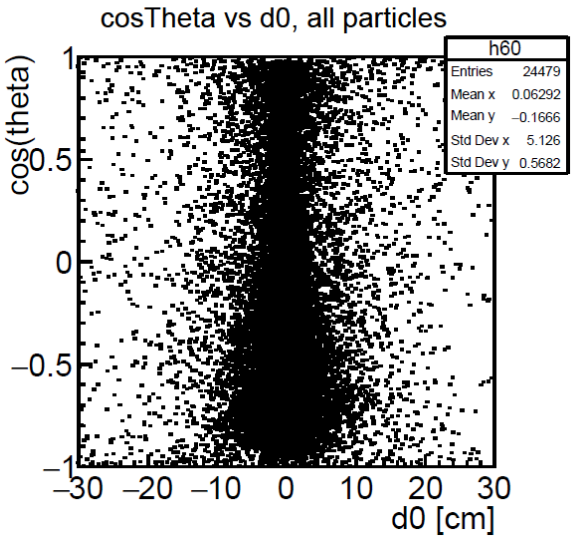

d0, all particles
h10
Entries 24479
Mean 0.06292
Std Dev 5.126
d0 [cm]


z0, all particles
h20
Entries 24479
Mean 39.84
Std Dev 57.97
z0 [cm]

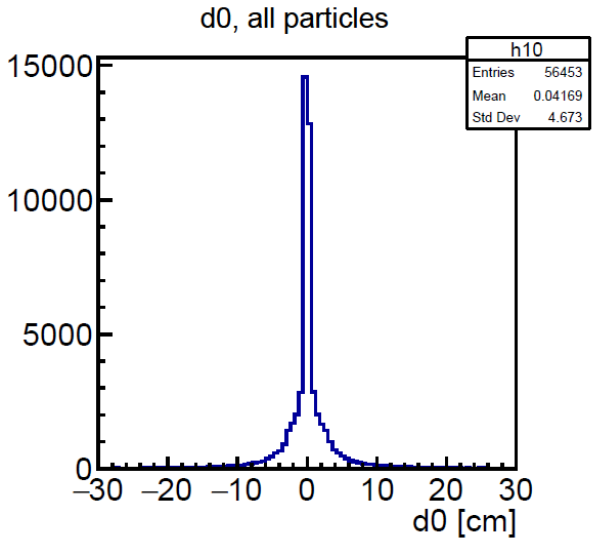

cosTheta, all particles
h50
Entries 24479
Mean −0.1631
Std Dev 0.5713
cos(theta)

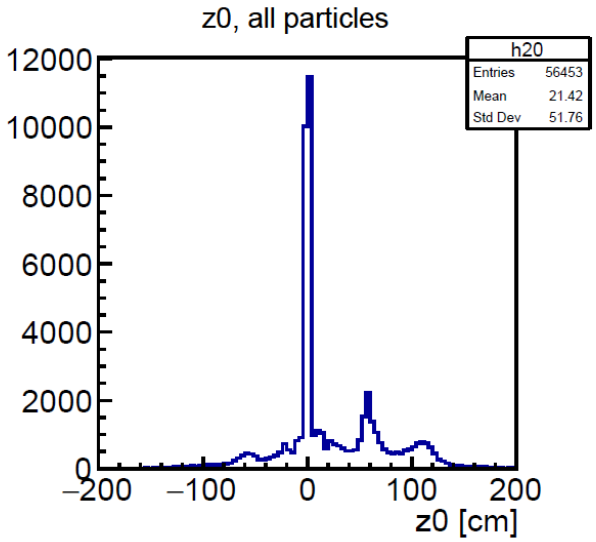

d0 vs z0, all particles
h30
Entries 24479
Mean x 40.18
Mean y 0.06794
Std Dev x 57.21
Std Dev y 4.975
d0 [cm]
z0 [cm]

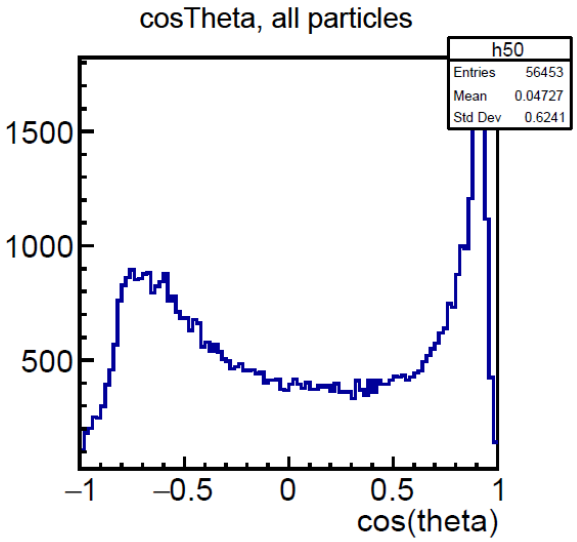

cosTheta vs z0, all particles
h40
Entries 24479
Mean x 39.84
Mean y −0.1595
Std Dev x 57.97
Std Dev y 0.5663
cos(theta)
z0 [cm]

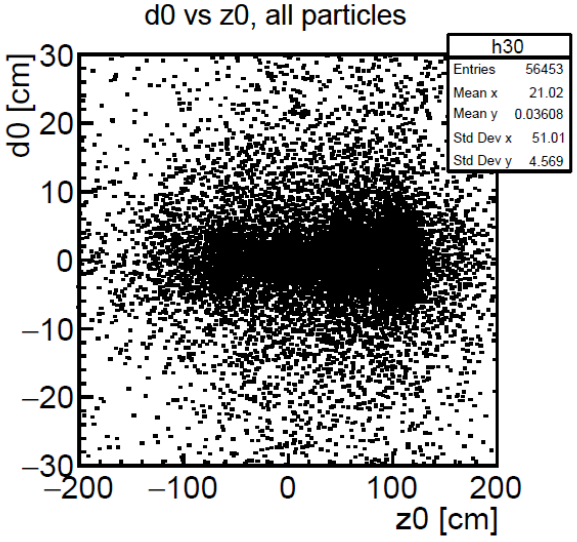

cosTheta vs d0, all particles
h60
Entries 24479
Mean x 0.06292
Mean y −0.1666
Std Dev x 5.126
Std Dev y 0.5682
cos(theta)
d0 [cm]

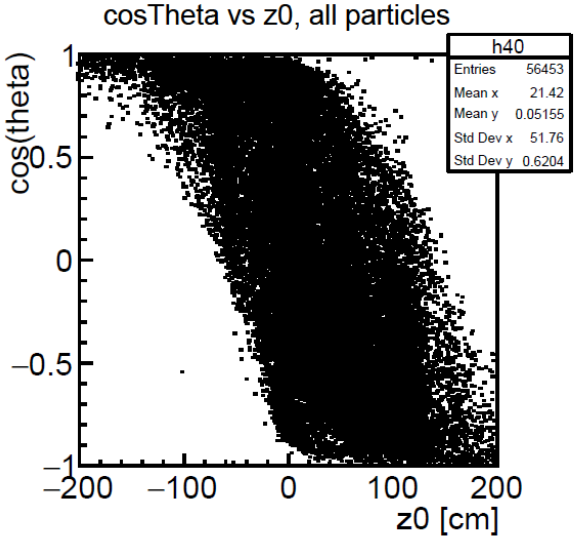
Run 5187

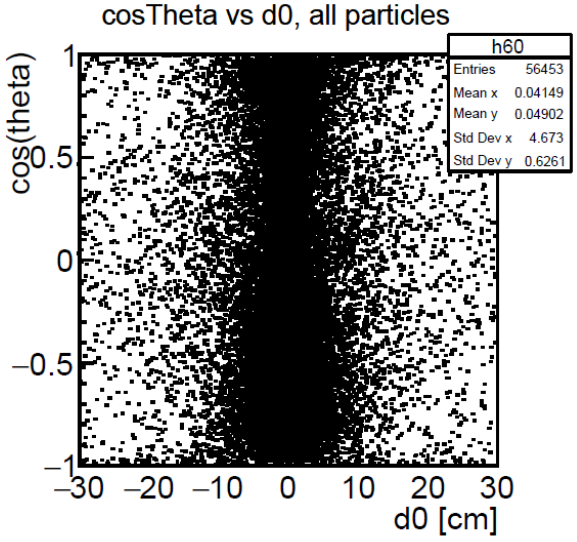

d0, all particles
h10
Entries 56453
Mean 0.04169
Std Dev 4.673
15000
10000
5000
0
−30 −20 −10 0 10 20 30
d0 [cm]


z0, all particles
h20
Entries 56453
Mean 21.42
Std Dev 51.76
12000
10000
8000
6000
4000
2000
0
−200 −100 0 100 200
z0 [cm]


cosTheta, all particles
h50
Entries 56453
Mean 0.04727
Std Dev 0.6241
1500
1000
500
−1 −0.5 0 0.5 1
cos(theta)

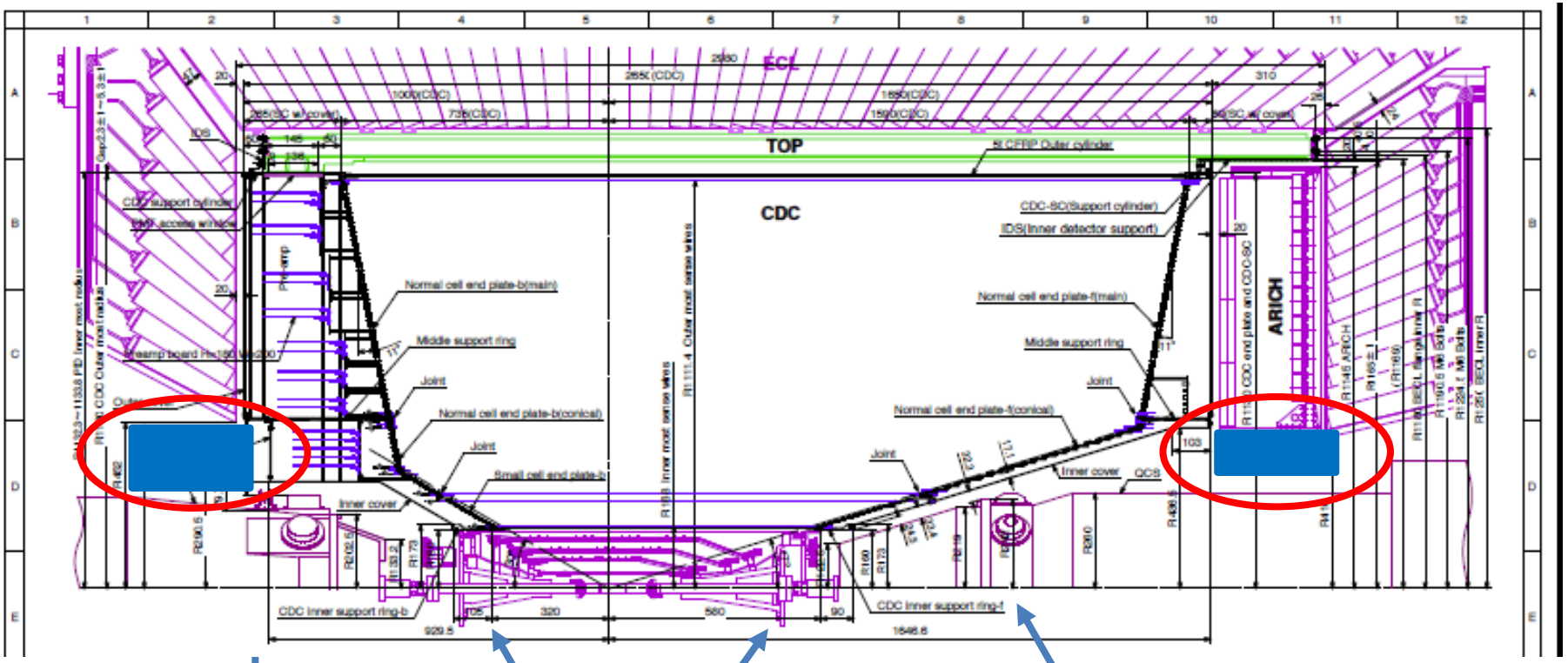

d0 vs z0, all particles
h30
Entries 56453
Mean x 21.02
Mean y 0.03608
Std Dev x 51.01
Std Dev y 4.569
30
20
10
0
−10
−20
−30
d0 [cm]
−200 −100 0 100 200
z0 [cm]


cosTheta vs z0, all particles
h40
Entries 56453
Mean x 21.42
Mean y 0.05155
Std Dev x 51.76
Std Dev y 0.6204
1
0.5
0
−0.5
−1
cos(theta)
−200 −100 0 100 200
z0 [cm]


cosTheta vs d0, all particles
h60
Entries 56453
Mean x 0.04149
Mean y 0.04902
Std Dev x 4.673
Std Dev y 0.6261
1
0.5
0
−0.5
−1
cos(theta)
−30 −20 −10 0 10 20 30
d0 [cm]

Overview of Service Areas

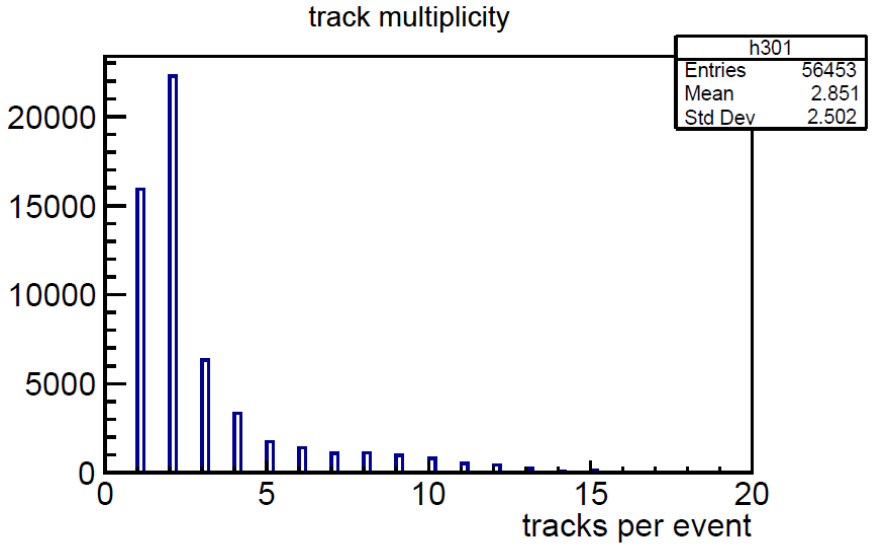
General rule: all services must have a connection at the docks

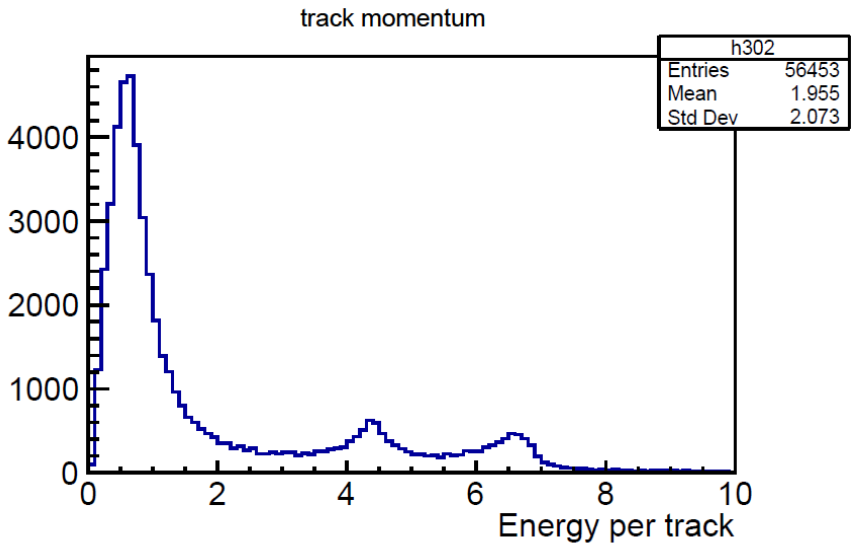


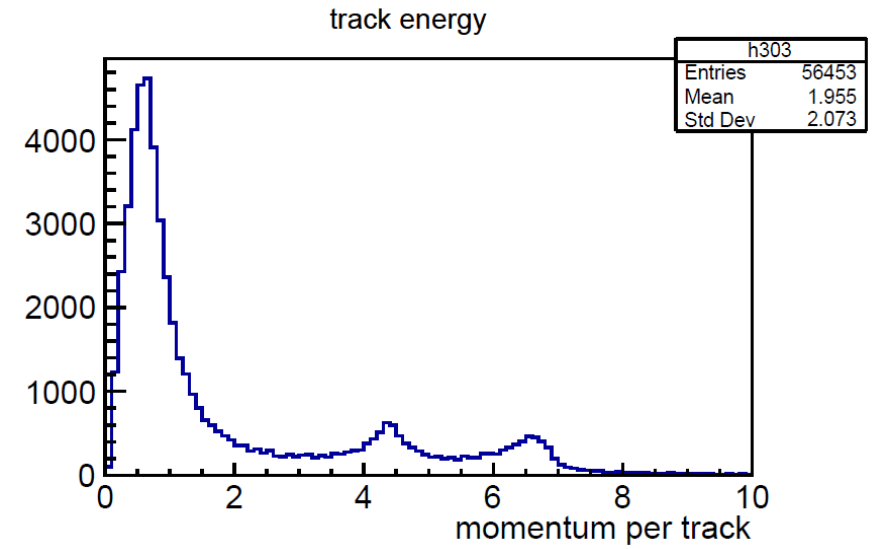
Heavy Metal (W) for shielding against particle background
~ +- 50 cm

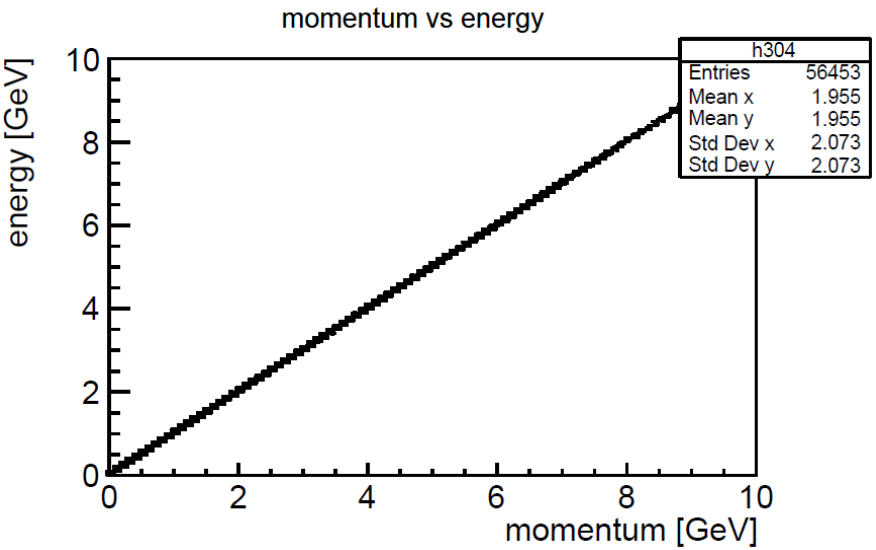
QCS internal (W) shielding against particle background (quench protection)
~ + 100 cm

Run 5187

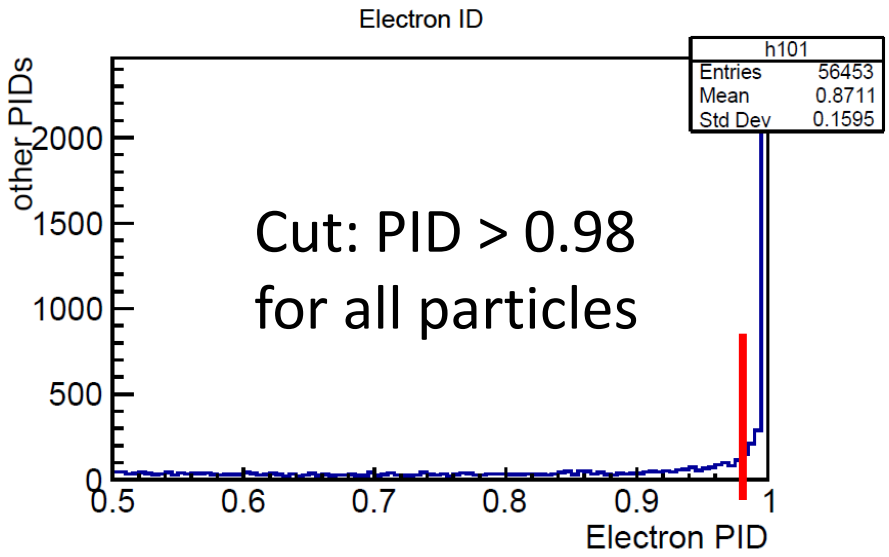

track multiplicity
h301
Entries 56453
Mean 2.851
Std Dev 2.502
20000
15000
10000
5000
0
0
5
10
15
20
tracks per event

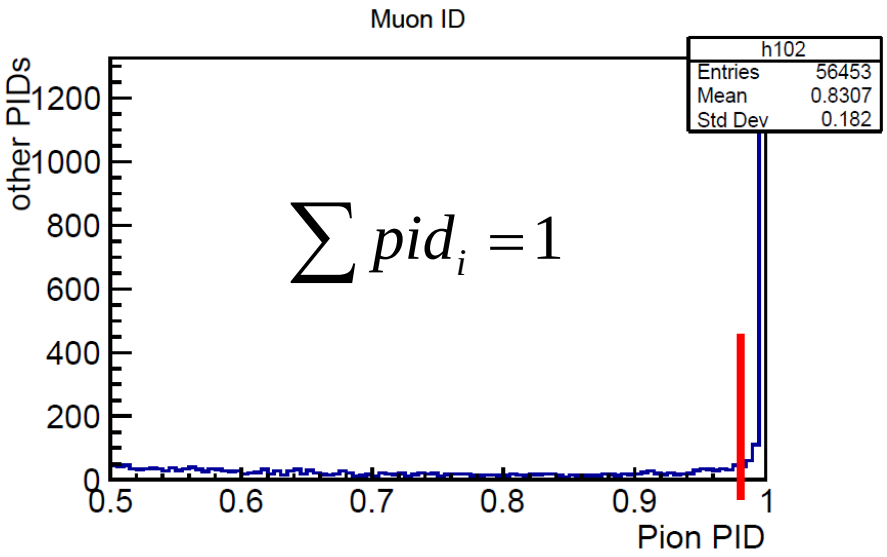

track momentum
h302
Entries 56453
Mean 1.955
Std Dev 2.073
4000
3000
2000
1000
0
0
2
4
6
8
10
Energy per track

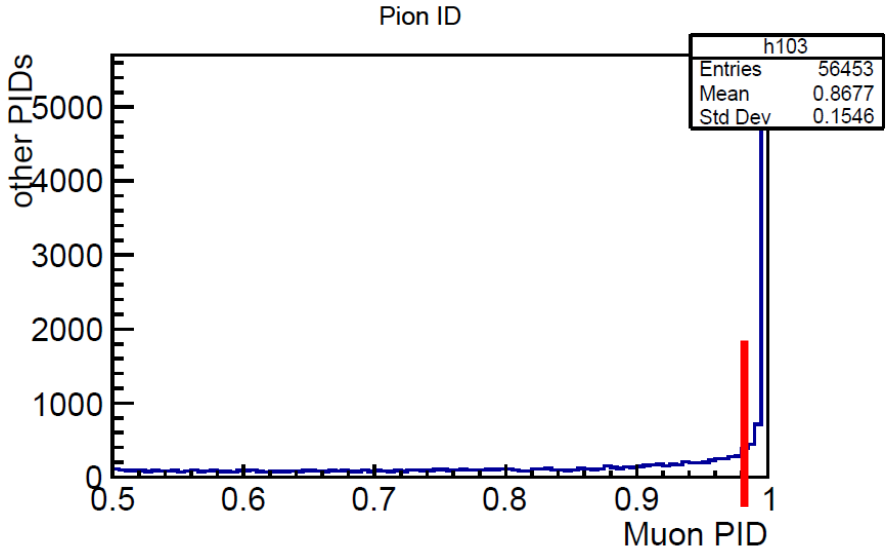

track energy
h303
Entries 56453
Mean 1.955
Std Dev 2.073
4000
3000
2000
1000
0
0
2
4
6
8
10
momentum per track

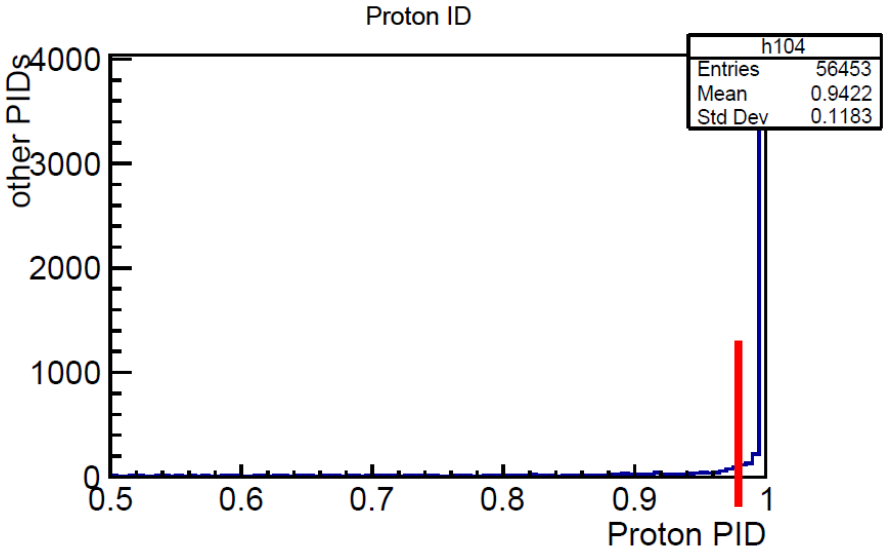

momentum vs energy
h304
Entries 56453
Mean x 1.955
Mean y 1.955
Std Dev x 2.073
Std Dev y 2.073
energy [GeV]
10
8
6
4
2
0
0
2
4
6
8
10
momentum [GeV]

Run 5187

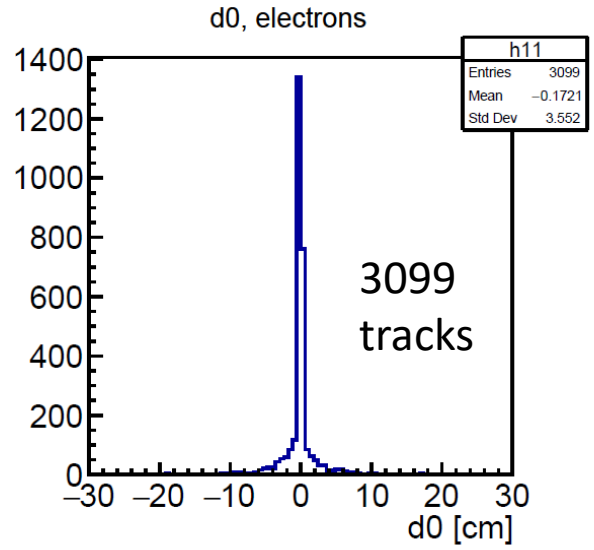

Electron ID
h101
Entries 56453
Mean 0.8711
Std Dev 0.1595
other PIDs
Electron PID
Cut: PID > 0.98
for all particles

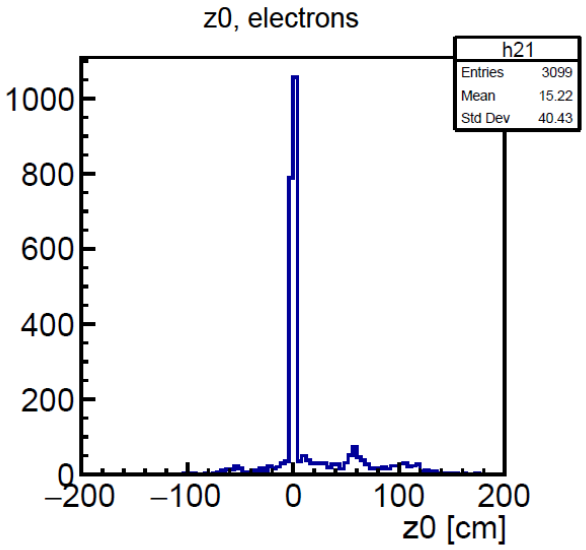

Muon ID
h102
Entries 56453
Mean 0.8307
Std Dev 0.182
other PIDs
Pion PID
$\sum pid_i = 1$

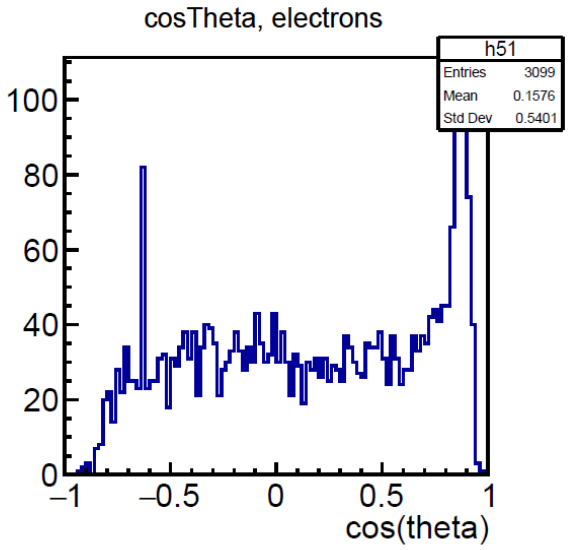

Pion ID
h103
Entries 56453
Mean 0.8677
Std Dev 0.1546
other PIDs
Muon PID

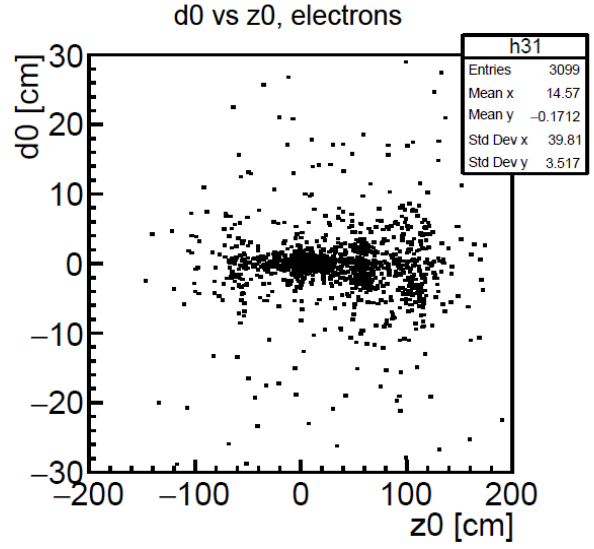

Proton ID
h104
Entries 56453
Mean 0.9422
Std Dev 0.1183
other PIDs
Proton PID

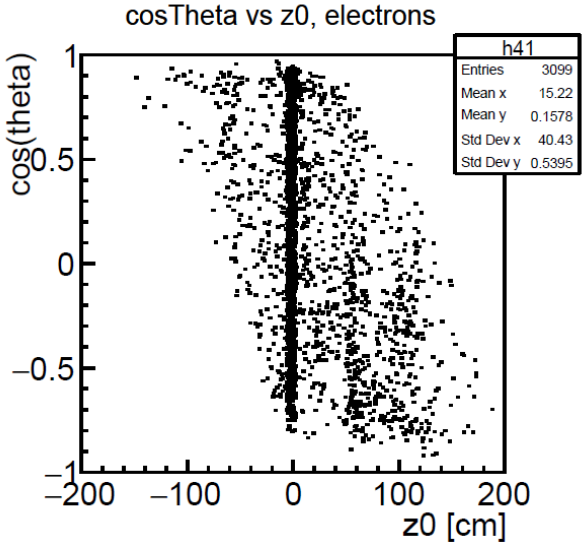
Run 5187

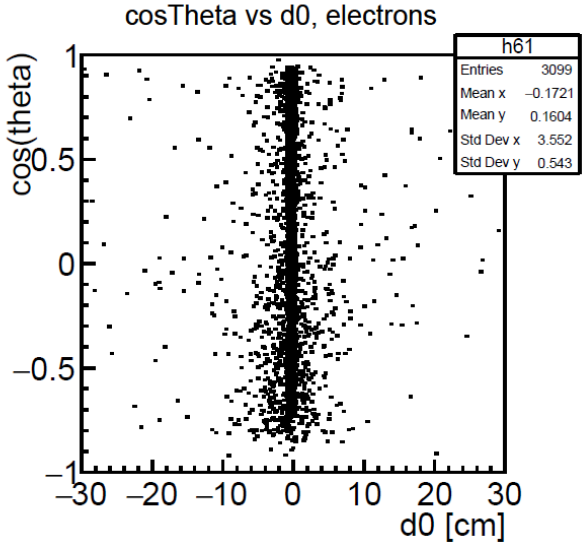

d0, electrons
h11
Entries 3099
Mean −0.1721
Std Dev 3.552
3099
tracks
d0 [cm]


z0, electrons
h21
Entries 3099
Mean 15.22
Std Dev 40.43
z0 [cm]

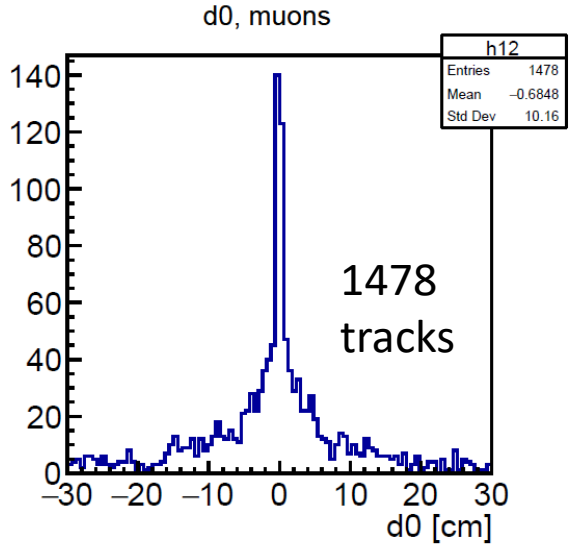

cosTheta, electrons
h51
Entries 3099
Mean 0.1576
Std Dev 0.5401
cos(theta)

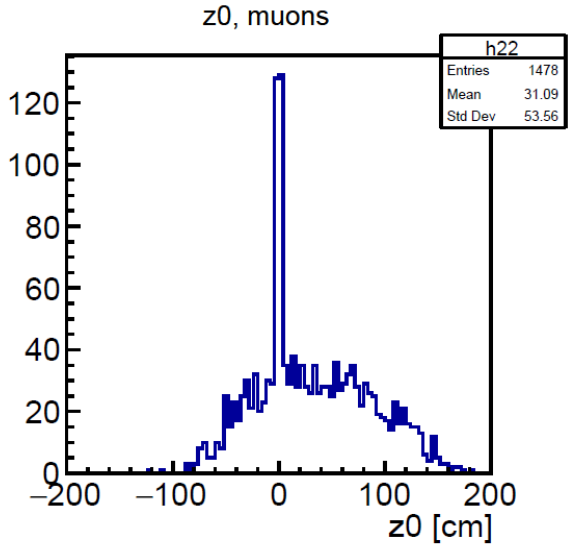

d0 vs z0, electrons
h31
Entries 3099
Mean x 14.57
Mean y −0.1712
Std Dev x 39.81
Std Dev y 3.517
d0 [cm]
z0 [cm]

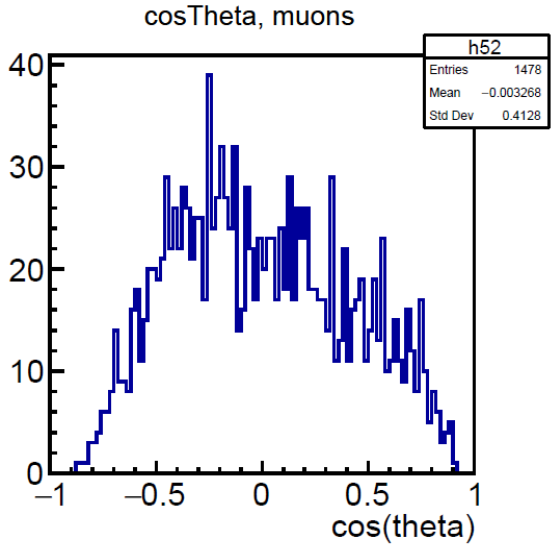

cosTheta vs z0, electrons
h41
Entries 3099
Mean x 15.22
Mean y 0.1578
Std Dev x 40.43
Std Dev y 0.5395
cos(theta)
z0 [cm]

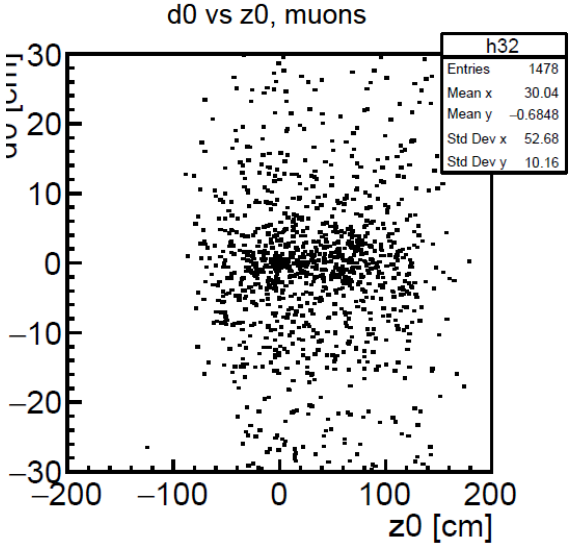

cosTheta vs d0, electrons
h61
Entries 3099
Mean x −0.1721
Mean y 0.1604
Std Dev x 3.552
Std Dev y 0.543
cos(theta)
d0 [cm]

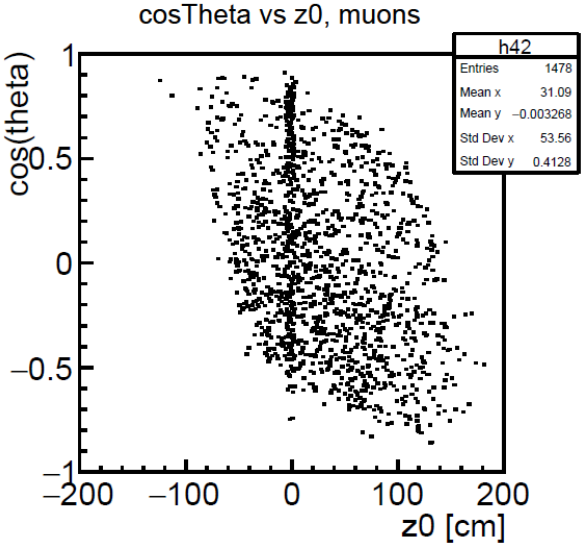
Run 5187

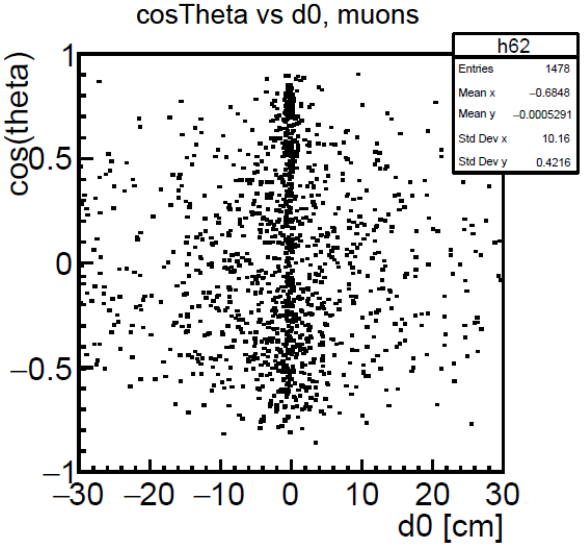

d0, muons
h12
Entries 1478
Mean −0.6848
Std Dev 10.16
1478
tracks
d0 [cm]


z0, muons
h22
Entries 1478
Mean 31.09
Std Dev 53.56
z0 [cm]

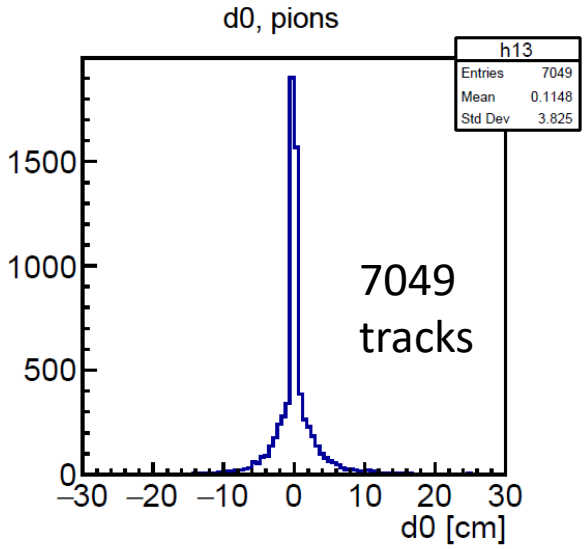

cosTheta, muons
h52
Entries 1478
Mean −0.003268
Std Dev 0.4128
cos(theta)

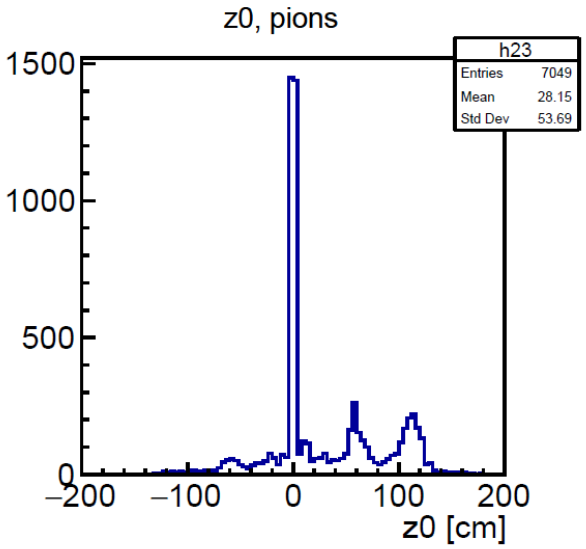

d0 vs z0, muons
h32
Entries 1478
Mean x 30.04
Mean y −0.6848
Std Dev x 52.68
Std Dev y 10.16
z0 [cm]

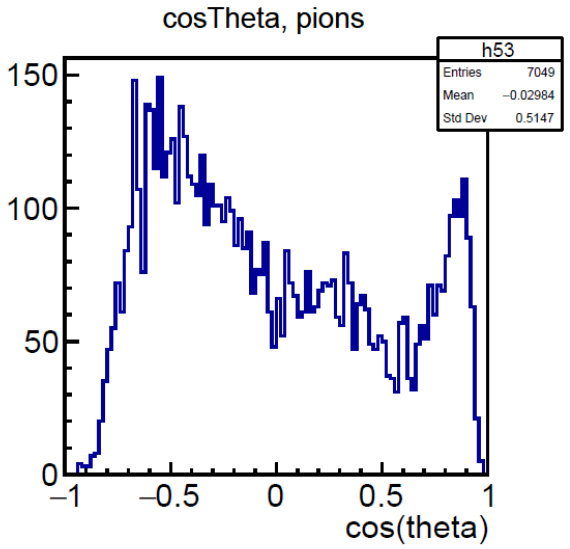

cosTheta vs z0, muons
h42
Entries 1478
Mean x 31.09
Mean y −0.003268
Std Dev x 53.56
Std Dev y 0.4128
cos(theta)
z0 [cm]

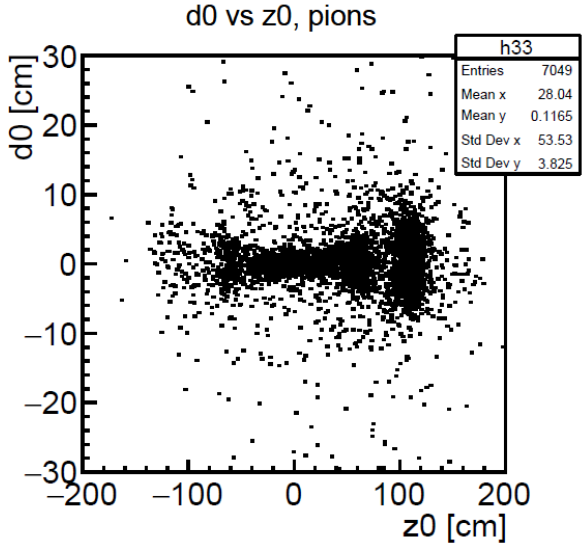

cosTheta vs d0, muons
h62
Entries 1478
Mean x −0.6848
Mean y −0.0005291
Std Dev x 10.16
Std Dev y 0.4216
cos(theta)
d0 [cm]

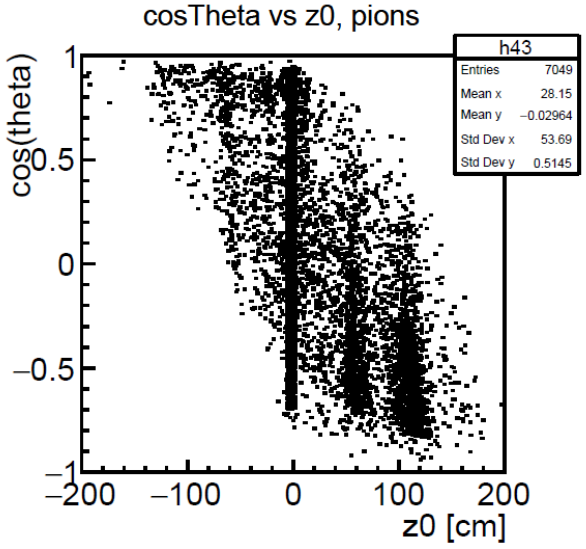
Run 5187

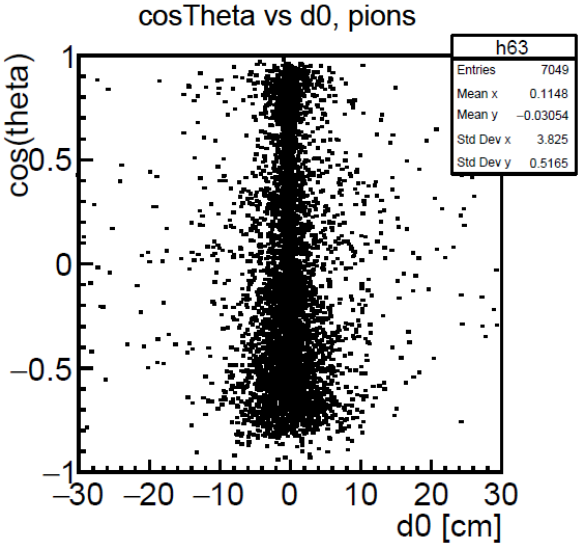

d0, pions
h13
Entries 7049
Mean 0.1148
Std Dev 3.825
7049
tracks
d0 [cm]


z0, pions
h23
Entries 7049
Mean 28.15
Std Dev 53.69
z0 [cm]

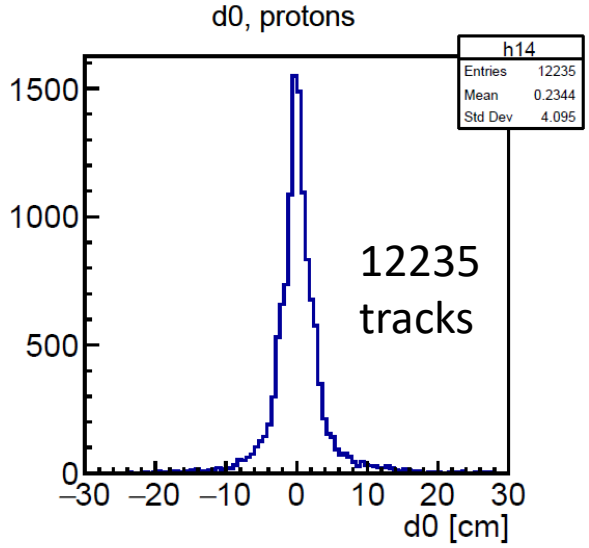

cosTheta, pions
h53
Entries 7049
Mean −0.02984
Std Dev 0.5147
cos(theta)

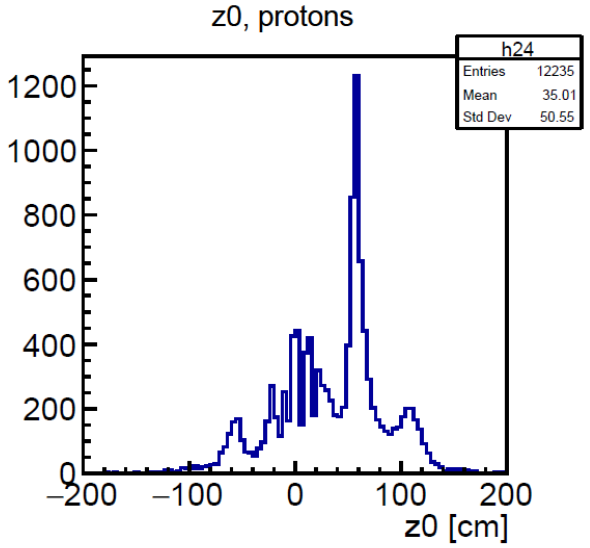

d0 vs z0, pions
h33
Entries 7049
Mean x 28.04
Mean y 0.1165
Std Dev x 53.53
Std Dev y 3.825
d0 [cm]
z0 [cm]

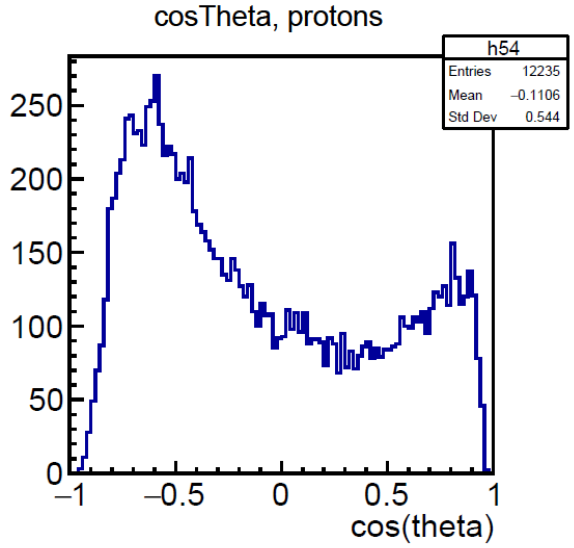

cosTheta vs z0, pions
h43
Entries 7049
Mean x 28.15
Mean y −0.02964
Std Dev x 53.69
Std Dev y 0.5145
cos(theta)
z0 [cm]

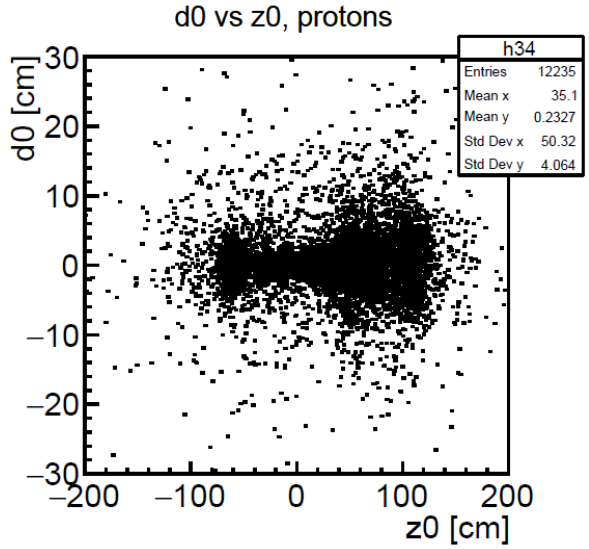

cosTheta vs d0, pions
h63
Entries 7049
Mean x 0.1148
Mean y −0.03054
Std Dev x 3.825
Std Dev y 0.5165
cos(theta)
d0 [cm]

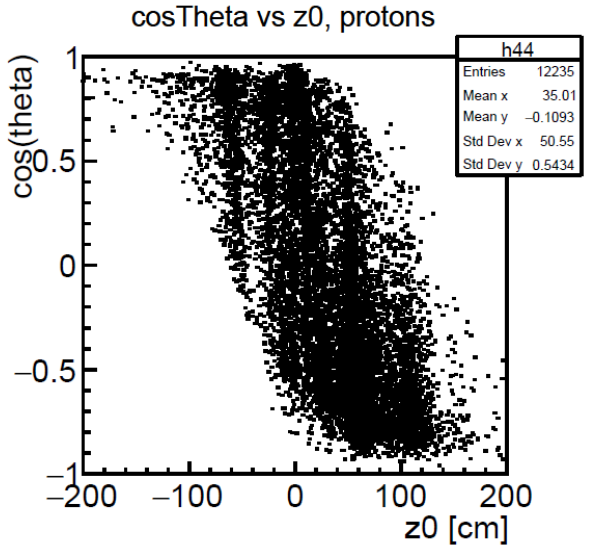
Run 5187

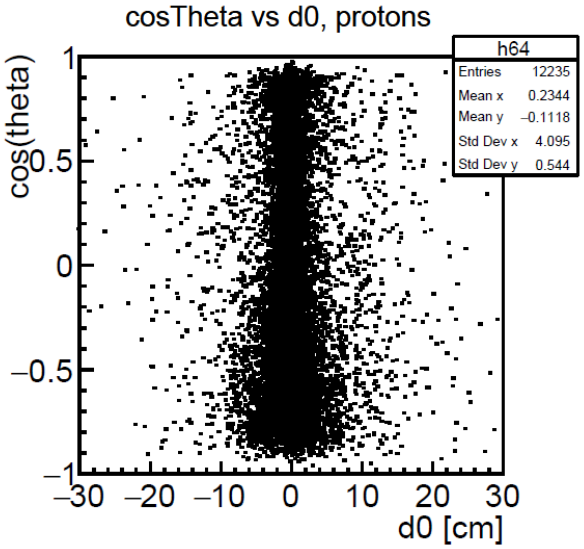

d0, protons
h14
Entries 12235
Mean 0.2344
Std Dev 4.095
12235
tracks
d0 [cm]


z0, protons
h24
Entries 12235
Mean 35.01
Std Dev 50.55
z0 [cm]

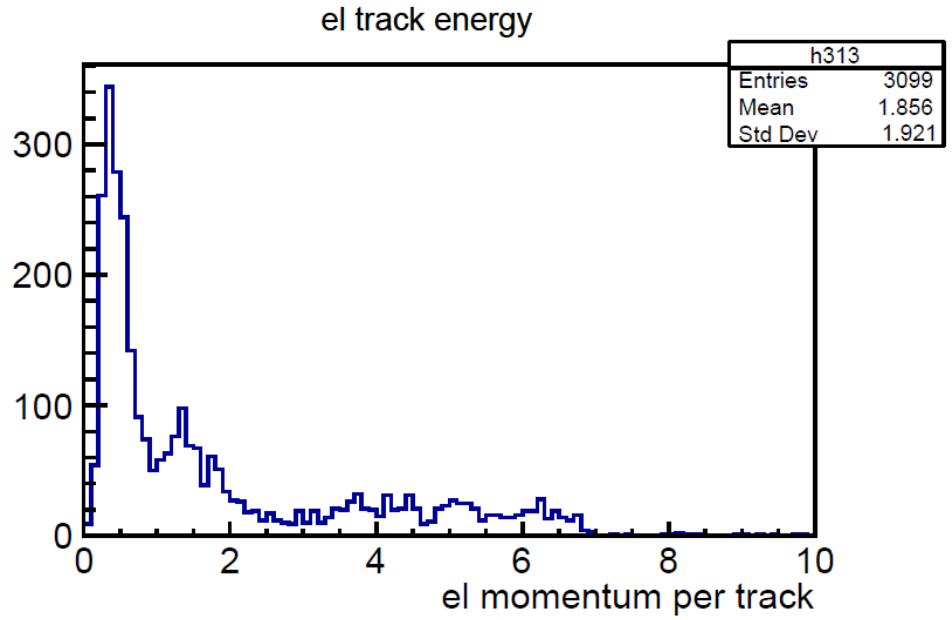

cosTheta, protons
h54
Entries 12235
Mean −0.1106
Std Dev 0.544
cos(theta)

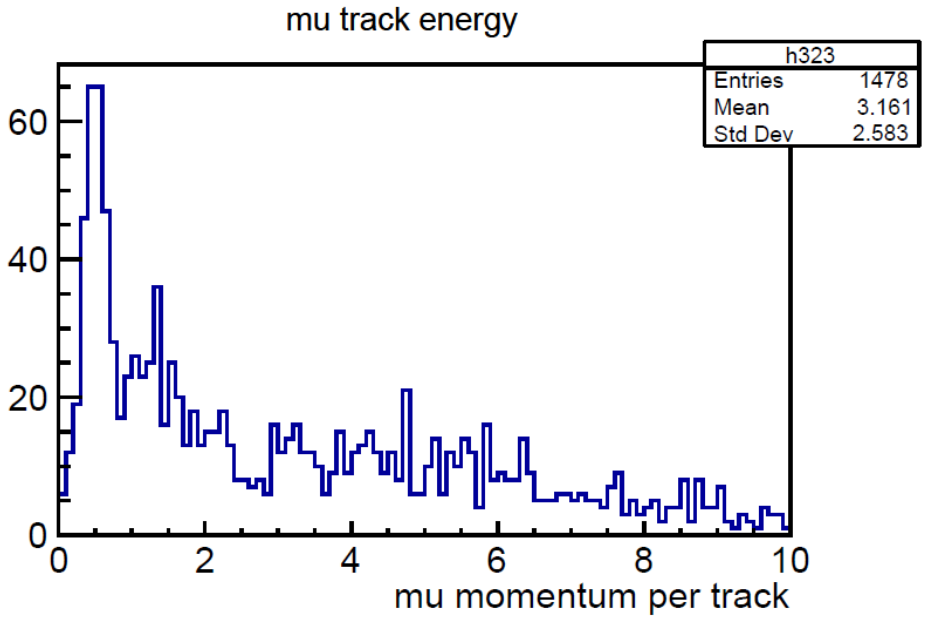

d0 vs z0, protons
h34
Entries 12235
Mean x 35.1
Mean y 0.2327
Std Dev x 50.32
Std Dev y 4.064
d0 [cm]
z0 [cm]

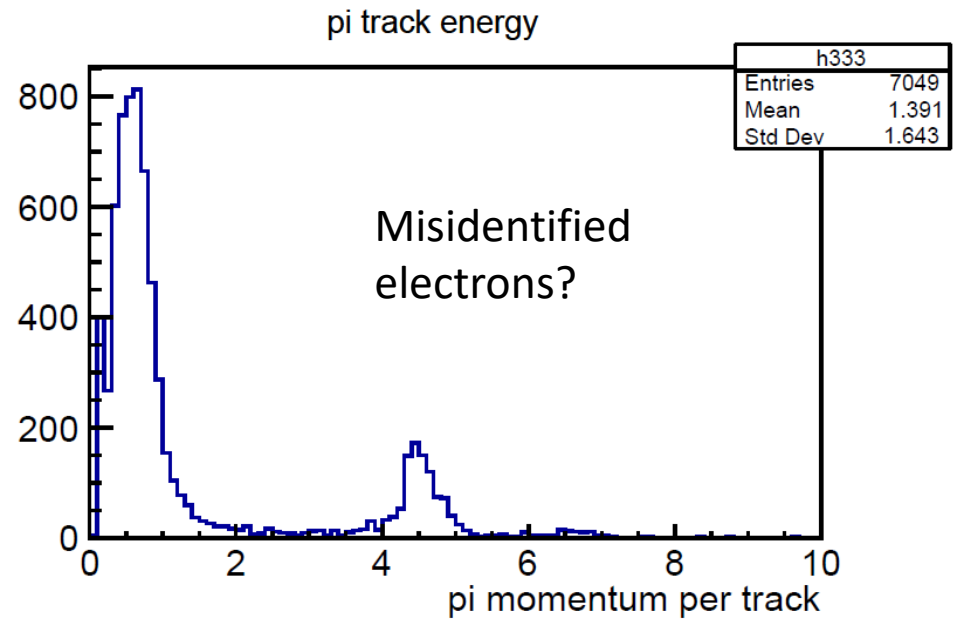

cosTheta vs z0, protons
h44
Entries 12235
Mean x 35.01
Mean y −0.1093
Std Dev x 50.55
Std Dev y 0.5434
cos(theta)
z0 [cm]

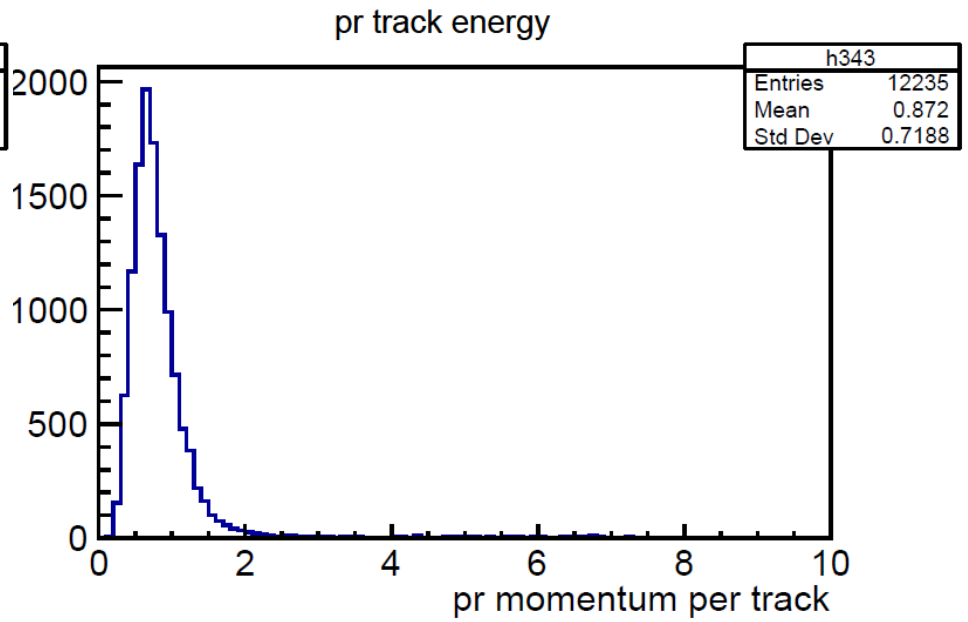

cosTheta vs d0, protons
h64
Entries 12235
Mean x 0.2344
Mean y −0.1118
Std Dev x 4.095
Std Dev y 0.544
cos(theta)
d0 [cm]

Run 5187

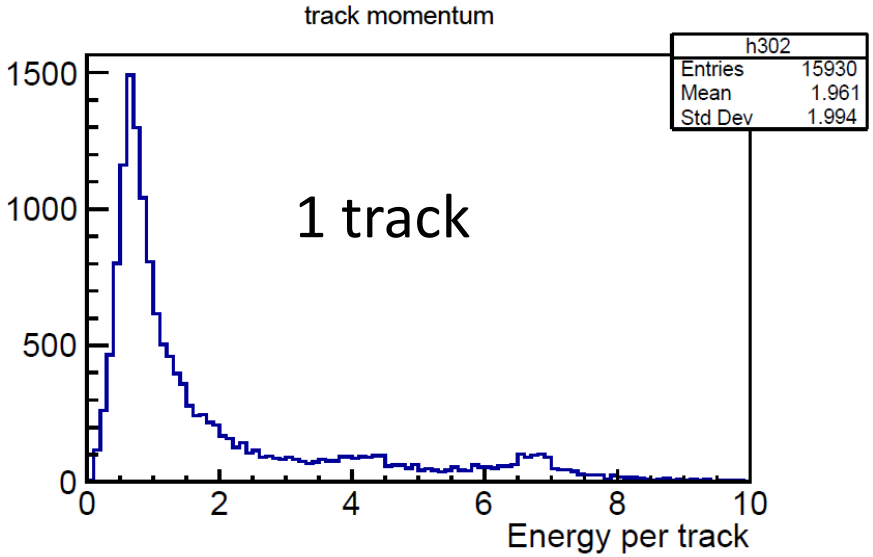

el track energy
h313
Entries 3099
Mean 1.856
Std Dev 1.921
el momentum per track

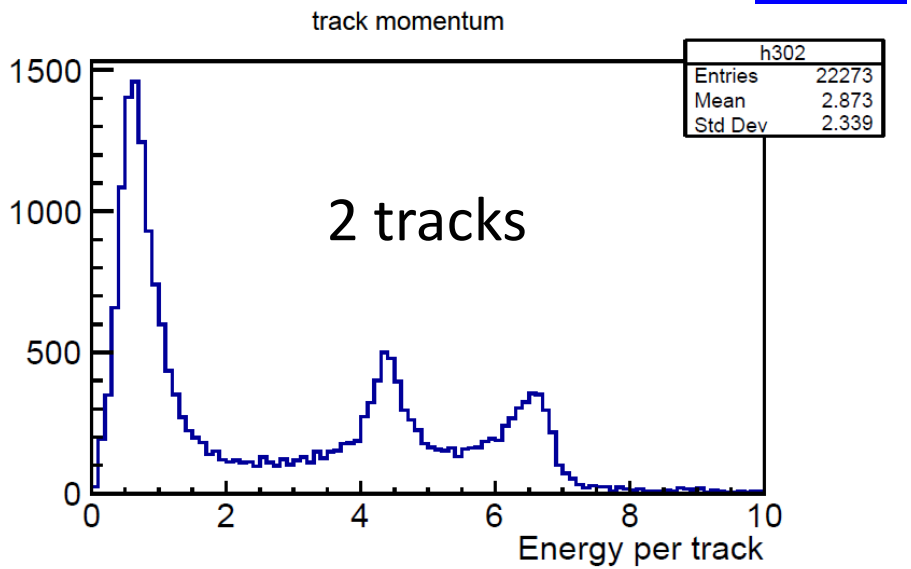

mu track energy
h323
Entries 1478
Mean 3.161
Std Dev 2.583
mu momentum per track

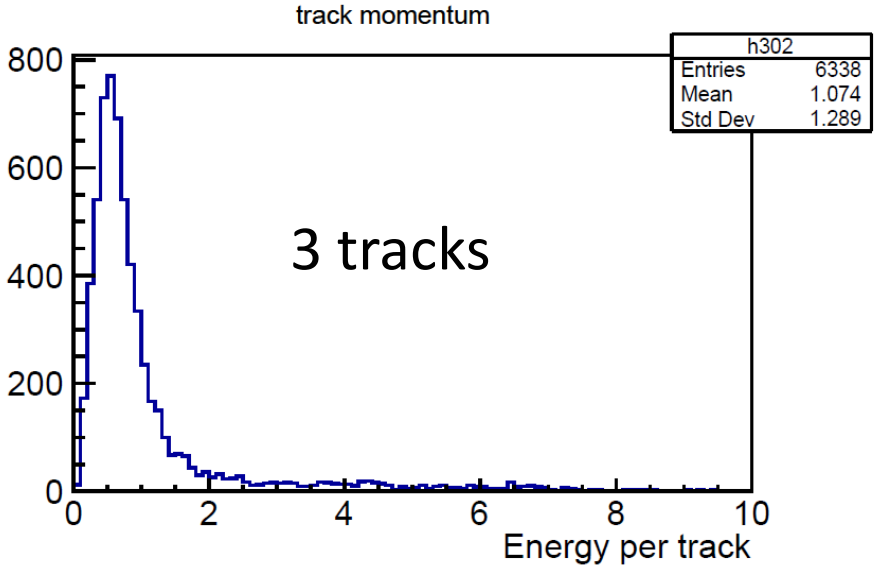

pi track energy
h333
Entries 7049
Mean 1.391
Std Dev 1.643
Misidentified electrons?
pi momentum per track

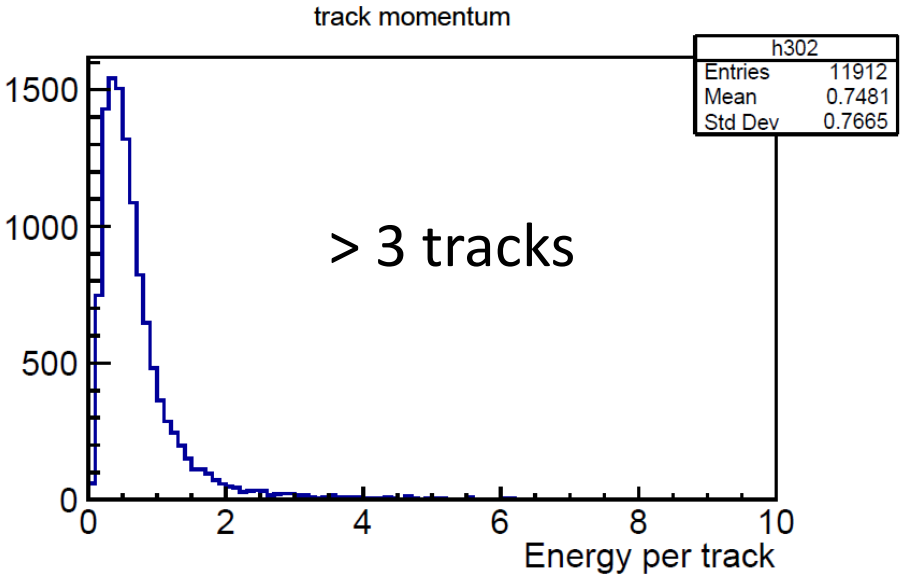

pr track energy
h343
Entries 12235
Mean 0.872
Std Dev 0.7188
pr momentum per track

Run 5187


track momentum
h302
Entries 15930
Mean 1.961
Std Dev 1.994
1 track
Energy per track


track momentum
h302
Entries 22273
Mean 2.873
Std Dev 2.339
2 tracks
Energy per track


track momentum
h302
Entries 6338
Mean 1.074
Std Dev 1.289
3 tracks
Energy per track


track momentum
h302
Entries 11912
Mean 0.7481
Std Dev 0.7665
> 3 tracks
Energy per track

Conclusions

Track parameters extracted from DST reconstruction

Background strongly changes with beam conditions

Possible reasons: towards end of Phase 2

- the vaccum improved
- injection better understood

Looking at different particle types:

- clear difference in particle spectra
- z <> 0 tracks very numerous relative to vertex tracks
- backgrounds look similar in shape, ~ independent of BG level
  (prominent peak at ~+50 („heavy metal“) ~+100 („QCS tip“)
- background has low multiplicity (> 3 tracks -> multi-hadrons)
- muons are dominated by cosmics
- Bhabhas clearly visible in the 2-track sample
- what is the 4 GeV peak for pions (misidentified electrons?)